Small Business Innovation Research/Small Business Tech Transfer

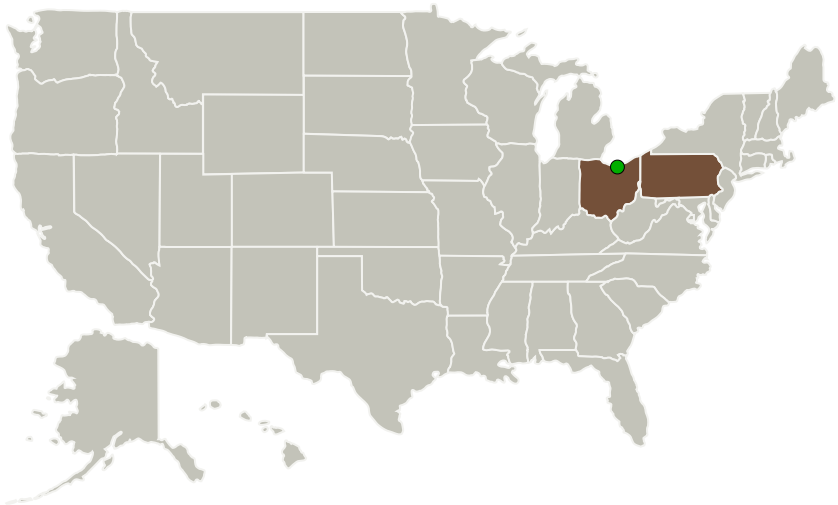
A Mathematical Model to Assess CMAS Damage in EBCs, Phase I

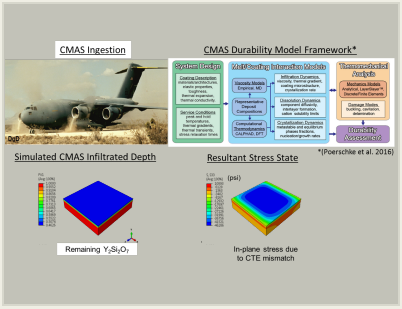
Completed Technology Project (2017 - 2017)

Project Introduction

As the power density of advanced engines increases, the need for new materials that are capable of higher operating temperatures, such as ceramic matrix composites (CMCs), is critical for turbine hot-section static and rotating components. Such advanced materials have demonstrated the promise to significantly increase the engine temperature capability relative to conventional super alloy metallic blades. They also show the potential to enable longer life, reduced emissions, growth margin, reduced weight and increased performance relative to super alloy blade materials. Environmental Barrier Coatings (EBCs) are required for SiC-based composites used in hot-section components of aircraft turbine engines to limit degradation from reaction of the composite with combustion gases. EBCs themselves are subject to degradation when debris composed of calcium-magnesium alumino-silicates (CMAS) is ingested into the engine melts in the turbine hot-section, and deposits on the coated components. The CMAS reacts with the coating and degrades the mechanical properties of the coating during temperature cycling which occurs during normal engine operation. Models linking the thermochemical and thermomechanical degradation of the EBCs due to CMAS are needed to understand life of the coatings and to identify best strategies for developing improved coating systems. MR&D is proposing a combined analytical and experimental program to develop a mathematical model for CMC EBCs exposed to CMAS.

Primary U.S. Work Locations and Key Partners





A Mathematical Model to Assess CMAS Damage in EBCs, Phase I Briefing Chart Image

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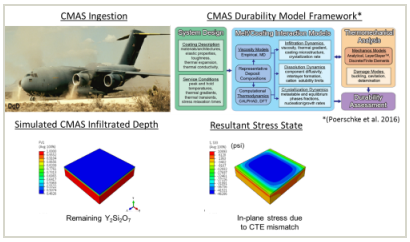
Organizations Performing Work	Role	Type	Location
Materials Research and Design, Inc.	Lead Organization	Industry	Wayne, Pennsylvania
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Ohio	Pennsylvania

Images



Briefing Chart Image
A Mathematical Model to Assess CMAS Damage in EBCs, Phase I Briefing Chart Image *(https://techport.nasa.gov/image/128248)*

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Materials Research and Design, Inc.

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

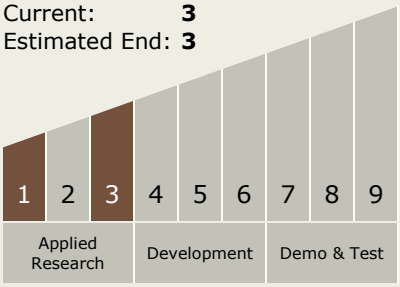
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Michael Dion

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**



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Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.2 Computational Materials

Other/Cross-cutting:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.5 Coatings
    - TX12.1.6 Materials for Electrical Power Generation, Energy Storage, Power Distribution and Electrical Machines

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System